	PCr-rest	PCr-6 min	pH-rest	pH-6 min
Training	0.89 ± 0.01	0.44 ± 0.04*	7.05 ± 0.01	6.85 ± 0.03*
Detraining	0.90 ± 0.01	0.38 ± 0.05	7.07 ± 0.01	6.82 ± 0.03

Data presented are mean value ± SEM. *p < 0.05 versus detraining.

1098-157 Impaired Vasodilatory Capacity in the Working Skeletal Muscle as a Determinant of Delayed Increased Oxygen Uptake During Exercise in Chronic Heart Failure

N. Komatsu, K. Maehara, H. Otani, A. Hirosaka, Y. Maruyama. *Fukushima Medical College, Japan*

The delay of the increase in oxygen uptake early in low-level activity in patients with chronic heart failure has been considered to depend on oxygen delivery to the working skeletal muscle. To investigate the linkage between oxygen uptake and cardiac output, and what causes the delayed circulatory adjustment at the onset of exercise, 12 patients with chronic stable heart failure performed a constant load supine bicycle ergometer exercise for 6 min (Ex), under catheterizations to pulmonary artery, brachial artery and the left ventricle (LV). Work load (equivalent to VO2: 10 ml/Kg/min) was determined by incremental sitting bicycle exercise test before the study. Cardiac output was measured by thermodilution method and pressure measurements were performed every one min during Ex. Left ventriculogram was performed, and blood lactate and plasma norepinephrine (NE) concentrations were measured before and at 6 min of Ex. *Results:* VO2 at 6 min of Ex was 10.9 ± 1.3 ml/Kg/min (± SD) which was 54 ± 13% of peak VO2. The transient response of VO2 was characterized by first-order kinetics and the time constant (Tau) was 75 ± 37 sec. Tau correlated with the rate of increase in cardiac output at 2 min of Ex (23 ± 11%, $r = -0.59$, $p < 0.05$). The rate of increase in cardiac output did not correlate with resting LV ejection fraction but tended to correlate with the increased rate of left ventricular end-systolic pressure/volume ratio at 6 min, and significantly correlated with the rate of decrease in total systemic vascular resistance (−15.8 ± 9%, $r = -0.85$, $p < 0.01$, at 2 min of Ex). Lactate (2.8 ± 1.0 mmol/L) at 6 min tended to correlate with Tau ($r = -0.55$, $p = 0.06$). In conclusion, delayed increase in oxygen uptake in the early phase of exercise incurred in patients with chronic heart failure would mainly reflect impaired vasodilatory response in the working skeletal muscle.

1098-158 Comparison of Maximal vs Submaximal Exercise Protocols: The Reproducibility of the Neurohumoral Response in Patients with Heart Failure

K. Dickstein, T. Aarsland, P. Chang. *Hjertelaget Research Foundation, Stavanger, Norway*

Background: Evaluation of functional status in patients with heart failure requires a reproducible, clinically relevant exercise protocol. The 2 most commonly employed walking protocols are essentially different. Maximal treadmill testing employs an incremental work load whereas the submaximal 6 min walk test allows the patient to adjust work rate. Measurement of the peak achieved noradrenaline concentration permits comparison of the degree of effort.

Methods: Performance during 6 min walk and incremental treadmill testing was compared in 18 men in NYHA function class III (mean age 69 ± 8 years, mean EF 26 ± 5%). Patients performed both tests 3 times. Plasma noradrenaline was sampled at rest and immediately upon completion of each test.

Results:

	Rest	6 min walk	Treadmill
Noradrenaline (pg/ml), test #3	537 ± 252	2104 ± 998	3027 ± 1702
Correlations for test #2 vs #3:			
Noradrenaline (r)	0.800	0.864	0.753
Work performed (r)		0.989	0.874

Conclusions: The reproducibility of the 6 min walk test was superior to that of maximal, treadmill exercise testing with regard to both performance and peak noradrenaline. The marked difference in peak noradrenaline confirms that a level of effort consistent with daily activity is achieved during the 6 min walk test. This submaximal exercise protocol represents an attractive alternative to maximal exercise testing in the assessment of functional status in patients with heart failure.

1098-159 Effects of Exercise Training on Maximal and Submaximal Endurance Capacity in Men with Congestive Heart Failure

A.I. Larsen, T. Aarsland, M. Kristiansen, A. Haugland, K. Dickstein. *Hjertelaget Research Foundation, Stavanger, Norway*

Background: Exercise training improves both symptoms and maximal exercise performance in patients with congestive heart failure. Improvement is associated with histological and biochemical changes compatible with reversal of the deconditioning process. This trial evaluated the effect of a 12 week isotonic, aerobic training program on submaximal endurance capacity and maximal exercise performance.

Methods: 30 men (mean age 66 ± 7 years) with congestive heart failure in NYHA class III (mean EF 32 ± 5%) were evaluated prior to and following training, with 3 exercise protocols: a) Maximal cycle ergometer test using an incremental ramp protocol (15 W/min) with gas exchange collection, b) 6 min walk test, c) Submaximal endurance treadmill test (30 min duration, identical work load) with blood lactate sampling.

Results:

	Pretraining	Posttraining	p
Cycle peak oxygen uptake (ml/kg/min)	15.7 ± 2.7	16.4 ± 2.1	ns
Cycle total work performed (kJ)	28.4 ± 11.8	36.9 ± 13.7	< 0.01
6 min walk test (m)	517 ± 70	554 ± 56	< 0.01
Treadmill lactate (area under curve)	45 ± 14	36 ± 14	< 0.005

Conclusion: These results indicate that moderate aerobic training is associated with significant improvement in endurance capacity. Submaximal endurance tests may represent more sensitive and appropriate methods to assess the efficacy of intervention in this population. Specifically, demonstration of reduced lactate production at matched work intensities suggests increased dependence on aerobic substrate following training.

1098-160 Clinical, Hemodynamic, and Cardiopulmonary Exercise Test Predictors of Outcome in Patients Referred for Heart Failure Evaluation

J. Myers, L. Gullestad, R. Vagelos, D. Bellin, D. Do, H. Ross, M. Fowler. *Palo Alto DVAMC, Palo Alto CA, USA, Stanford University, Stanford CA, USA*

Background: Accurately establishing prognosis in CHF has become increasingly important in assessing the efficacy of treatment modalities and in appropriately allocating scarce resources for transplantation (Tx). Previous studies in severe CHF have been limited by short follow-up times and small numbers of deaths.

Methods: Six hundred forty four patients referred for heart failure evaluation between 1986 and 1995 were studied. After pharmacologic stabilization, all underwent cardiopulmonary exercise testing, and approximately two thirds underwent right heart catheterization and/or echocardiography. Univariate and multivariate analyses were performed for clinical, hemodynamic, and exercise test predictors of death, and a Cox hazards model was developed for time of death.

Results: Follow-up was complete on 98.3% of the cohort. During a mean follow-up period of 4 years, 187 patients (29%) died and 101 underwent Tx. Actuarial 1- and 5-year survival rates were 90.5 and 73.4%, respectively. Etiology of CHF (CAD or cardiomyopathy (CM)) was a strong determinant of survival (odds ratio 1.73 for CAD, $p < 0.01$); separate analyses were thus performed for these two groups. By multivariate analysis in each group, neither clinical or hemodynamic data significantly predicted death. Stratifying peak VO_2 above and below 12, 14 and 16 ml/kg/min significantly separated survivors from non-survivors and each yielded nearly identical survival curves. Among patients with underlying CAD, the combination of peak VO2 and maximal systolic blood pressure < 130 mmHg were the only significant predictors of death; among patients with CM, only peak VO_2 and advanced age significantly predicted death.

Conclusions: Peak VO_2 outperforms clinical and right heart catheterization data in predicting outcome in severe CHF.

1098-161 Body Composition and Quality of Muscle in Chronic Heart Failure

S.D. Anker[1,2], D. Harrington[1], B. Lees[1], T.P. Chua[1], P. Ponikowski[1], P.A. Poole-Wilson[1], A.J.S. Coats[1]. [1] *Dpt of Cardiac Medicine, NHLI, London, UK,* [2] *Dpt of Cardiology, University Halle/Saale, Germany*

Changes in skeletal muscle influence exercise capacity in CHF patients. We studied dual-energy x-ray absorptiometry in 14 healthy controls [Con],